REC'D 13 JAN 2005
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IB/05/050085

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Patentanmeldung Nr. Patent application No. Demande de brevet n°

04100081.1

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Anmeldung Nr:
Application no.: 04100081.1 ✓
Demande no:

Anmeldetag:
Date of filing: 12.01.04 ✓
Date de dépôt:

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If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Method and apparatus for controlling a readout parameter during reading

In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s) revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

G11B7/00

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL
PT RO SE SI SK TR LI

Method and apparatus for controlling a readout parameter during reading

The present invention relates to a method and to an apparatus for controlling at least one readout parameter, such as radiation power and/or field strength, during reading of a magneto-optical recording medium, such as a MAMMOS (Magnetic AMplifying Magneto-Optical System) disk, comprising a recording or storage layer and an expansion or read-out layer.

In magneto-optical storage systems, the minimum width of the recorded marks is determined by the diffraction limit, i.e. by the Numerical Aperture (NA) of the focusing lens and the laser wavelength. A reduction of the width is generally based on shorter wavelength lasers and higher NA focusing optics. During magneto-optical recording, the minimum bit length can be reduced to below the optical diffraction limit by using Laser Pulsed Magnetic Field Modulation (LP-MFM). In LP-MFM, the bit transitions are determined by the switching of the field and the temperature gradient induced by the switching of the laser. For read-out of the small crescent shaped marks recorded in this way, Magnetic Super Resolution (MSR) or Domain Expansion (DomEx) methods have to be used. These technologies are based on recording media with several magneto-static or exchange-coupled RE-TM layers. According to MSR, a read-out layer on a magneto-optical disk is arranged to mask adjacent bits during reading, while, according to domain expansion, a domain in the center of a spot is expanded. The advantage of the domain expansion technique over MSR results in that bits with a length below the diffraction limit can be detected with a similar signal-to-noise ratio (SNR) as bits with a size comparable to the diffraction limited spot. MAMMOS is a domain expansion method based on magneto-statically coupled storage and read-out layers, wherein a magnetic field modulation is used for expansion and collapse of expanded domains in the read-out layer.

In the above mentioned domain expansion techniques, like MAMMOS, a written mark from the storage layer is copied to the read-out layer upon laser heating with the help of an external magnetic field. Due to the low coercitivity of this read-out layer, the copied mark will expand to fill the optical spot and can be detected with a saturated signal level which is independent of the mark size. Reversal of the external magnetic field collapses

the expanded domain. A space in the storage layer, on the other hand, will not be copied and no expansion occurs.

The resolution of the MAMMOS read-out process, i.e. the smallest bit size that can be reproduced without interference from neighboring bits, is limited by the spatial extent (copy window) of the copy process, which is determined by the overlap of the temperature induced coercivity profile and the stray field profile of the bit pattern, which profile depends on the strength of the external magnetic field. The laser power that is used in the readout process should be high enough to enable copying. On the other hand, a higher laser power also increases the overlap due to the fact that the coercivity Hc decreases and the stray field increases with increasing temperature. When this overlap becomes too large, correct readout of a space is no longer possible because false signals are generated by neighboring marks. The difference between this maximum and the minimum laser power determines the power margin, which decreases strongly with decreasing bit length. Experiments have shown that with the current readout methods, bit lengths of 0.10 μm can be correctly detected, but at an extremely small power margin (i.e. 1 bit of a 16 bit DAC (Digital Analog Converter)). Hence, balance of the optical power and the intensity of the external magnetic field is an important factor for determining optimum conditions.

However, even if optimum conditions have been set during an initial stage of a reading operation, the initial balance may be disturbed during reading due to environmental changes. These environmental changes may comprise field blurring, disk tilt, temperature changes, thickness non-uniformities of the protective coat of the disk, influences of the slider movement on the magnetic head, etc. Thus, controlling the optical power and the magnetic field strength during readout is essential.

The JP-A-2000-215537 discloses a method and apparatus for controlling the optical power and/or the field strength of the external magnetic field by reading from a specific section on the disk an information defining a prescribed section on the disk and a pulse information defining a prescribed pulse number. Then, the number of pulses contained in the information read from the prescribed section is counted and compared with the pulse information. Based on the comparison result, the optical power or the field strength is adjusted.

Furthermore, the WO03/023767A2 discloses a system for controlling radiation power and/or field strength during a reading operation from a magneto-optical recording medium. A pulse pattern in the reading signal is analyzed, and the analyzing result is compared with a run length characteristic of the data stored in the storage layer of the

recording medium. Based on the comparison result, the radiation power and/or the magnetic field strength are controlled. Thereby, much less or no disc capacity has to be reserved for power and/or field calibration, since the user data can be used for this purpose.

Robust detection of run length violations means e.g. that the smallest allowed mark run length is not detected. Similarly, detection of a run length larger than the maximum allowed length indicates a run length violation. However, to detect the violation, e.g. number of additional or missing peaks, with a reasonable reliability, the observed (random) data sequence has to be sufficiently large. This means that a lot of data errors are made before a suitable control signal is obtained that can be used to correct the readout conditions. Moreover, the discrete nature of the error signal makes it far from straightforward to design a robust control loop.

Fig. 4 shows a diagram indicating an error signal value vs. readout parameters, where the error signal is varied in a stepwise manner depending on the value of the readout parameter(s). As indicated in Fig. 4, this becomes even worse in case of a non-uniformity in the disk's optical or magnetic properties, for example. When a readout parameter is just outside the nominal range, a number of data errors is made while the error signal is still zero. For example, a +1 peak may occur which is however still below the decision threshold and no corrective action is taken. Only when the readout parameter deviates sufficiently, the number of errors is large enough to generate an error signal. Hence, the conventional discrete nature of the error signal has the drawback of coarse control and slow response at a considerable amount of readout errors.

It is an object of the present invention to provide a method and apparatus for providing an improved readout parameter control with increased robustness.

This object is achieved by a method as claimed in claims 1, and by an apparatus as claimed in claims 14.

Accordingly, due to the continuous functional relationship between the error signal and the relative occurrence of runlength violations, a smooth error signal can be generated and undesired discrete jumps of the error signal value can be prevented. In particular, the value of the error signal can be adapted to the relative amount of runlength violations. This means that an improved control and response can be achieved with a reduced number of readout errors.

The predetermined functional relationship may comprise a proportional relationship. This proportional relationship may be provided in a transition region between a non-controlled region and a controlled region. Thereby, readout errors which are mainly caused in the transition region(s) due to disk non-uniformities can be significantly reduced.

The relative occurrence may be determined by calculating a running average of detected runlength violations. As an alternative, the determination may be based on a time-averaging or integration procedure. These alternative procedures provide simple solutions to the above problems associated with the discrete nature of the error signal.

The run length violations may be determined by a pulse counting function or by a timer function.

The pulse pattern used for the analysis may correspond to the user data recorded on the recording medium, or alternatively, the pulse pattern may correspond to a predetermined data pattern with pre-defined mark and space run length recorded at predetermined portions of the recording medium. The control may even be based on a combined evaluation or analysis of pre-defined or known data patterns and random user data. The pre-defined data patterns provide the advantage that runlength violations can be obtained directly by counting the detected number of peaks and subtracting the expected number. Therefore, only a few runlengths are sufficient for reliable detection. As an option, the error signal may be generated during reading of the predetermined portions and can be frozen or held constant during reading of other portions of the recording medium. The control based on the frozen error signal can be enhanced based on runlength variations detected from user data recorded on the other portions of the recording medium.

As a specific example, the predetermined portion may be an address header portion.

The comparison may be performed based on a look-up table linking the value of the error signal to a corresponding value of the relative occurrence of runlength violations.

Other advantageous further developments are defined in the dependent claims.

In the following, the present invention will be described on the basis of a preferred embodiment with reference to the accompanying drawings in which:

Fig. 1 shows a schematic diagram of a magneto-optical disk player, according to the preferred embodiment;

Fig. 2 shows signaling diagrams of a read-out strategy with different degrees of overlap;

Fig. 3 shows a table for determining a range of spatial width of a copy window based on a determined mark or space runlength;

Fig. 4 shows a diagram of an error signal vs. readout parameters for a prior art readout control with discrete nature of the error signal;

Fig. 5 shows a diagram of an error signal vs. readout parameters for an improved readout control with continuous nature of the error signal, according to the preferred embodiment; and

Fig. 6 shows a schematic flow diagram of control procedure according to the preferred embodiment.

A preferred embodiment will now be described on the basis of a MAMMOS disk player as indicated in Fig. 1.

Fig. 1 schematically shows the construction of the disk player according to the preferred embodiment. The disk player comprises an optical pick-up unit 30 having a laser light radiating section for irradiation of a magneto-optical recording medium or record carrier 10, such as a magneto-optical disk, with light that has been converted, during recording, to pulses with a period synchronized with code data and a magnetic field applying section comprising a magnetic head 12 which applies a magnetic field in a controlled manner at the time of recording and playback on the magneto-optical disk 10. In the optical pick-up unit 30 a laser is connected to a laser driving circuit which receives recording and readout pulses from a recording/readout pulse adjusting unit 32 to thereby control the pulse amplitude and timing of the laser of the optical pick-up unit 30 during a recording and readout operation. The recording/readout pulse adjusting circuit 32 receives a clock signal from a clock generator 26 which may comprise a PLL (Phase Locked Loop) circuit.

It is noted that, for reasons of simplicity, the magnetic head 12 and the optical pickup unit 30 are shown on opposite sides of the disk 10 in Fig. 1. However, according to the preferred embodiment, they should be arranged on the same side of the disk 10.

The magnetic head 12 is connected to a head driver unit 14 and receives, at the time of recording, code-converted data via a phase adjusting circuit 18 from a modulator 24. The modulator 24 converts input recording data to a prescribed code.

At the time of playback, the head driver 14 receives a clock signal via a playback adjusting circuit 20 from the clock generator 26, wherein the playback adjusting circuit 20 generates a synchronization signal for adjusting the timing and amplitude of pulses applied to the magnetic head 12. A recording/playback switch 16 is provided for switching or

selecting the respective signal to be supplied to the head driver 14 at the time of recording and at the time of playback.

Furthermore, the optical pick-up unit 30 comprises a detector for detecting laser light reflected from the disk 10 and for generating a corresponding reading signal applied to a decoder 28 which is arranged to decode the reading signal to generate output data. Furthermore, the reading signal generated by the optical pick-up unit 30 is supplied to a clock generator 26 in which a clock signal obtained from embossed clock marks of the disk 10 is extracted, and which supplies the clock signal for synchronization purposes to the recording pulse adjusting circuit 32, the playback adjusting circuit 20, and the modulator 24. In particular, a data channel clock may be generated in the PLL circuit of the clock generator 26.

In case of data recording, the laser of the optical pick-up unit 30 is modulated with a fixed frequency corresponding to the period of the data channel clock, and the data recording area or spot of the rotating disk 10 is locally heated at equal distances. Additionally, the data channel clock output by the clock generator 26 controls the modulator 24 to generate a data signal with the standard clock period. The recording data are modulated and code-converted by the modulator 24 to obtain a binary runlength information corresponding to the information of the recording data.

The structure of the magneto-optical recording medium 10 may correspond to the structure described in the JP-A-2000-260079.

The occurrence of false signals due to a large overlap (e.g. laser power too high) should normally be avoided. However, if the correct data in the storage layer is known, the occurrence and number of false peaks gives a direct information on the spatial width of the copy window which is directly related to the thermal laser profile. This information can not only be used to correct the previous and/or following data on the disc, but also provides a direct way to correct readout parameters, such as the laser power and or the field strength of the external magnetic field.

In the embodiment shown in Fig. 1, the laser power and/or the strength of the external magnetic field are controlled as examples of possible readout parameters. However, other suitable readout parameters having influence on the copy window size or phase may be controlled as well. A control unit 25 is provided for supplying first and second control or error signals 38, 39 to the head driver 14 and/or to the optical pickup unit 30. The first control signal 38 is supplied to the optical pickup unit 30 and can be used for adjusting the driving current of a laser diode or another radiation source, so as to adjust the optical radiation or laser power used for heating the disk 10. The second error signal 39 is supplied to the head

driver and can be used to adjust the field current of a coil arrangement provided at the magnetic head, so as to adjust the field strength or intensity of the external magnetic field. The two error signals 38, 39 may be provided as alternative or combined error signals. In the latter case, the second error signal 39 supplied to the head driver 14 may be used for fine adjustment of the balance between the optical power and the field strength, while the first error signal 39 supplied to the optical pickup unit 30 may be used for rough adjustment. This is due to the fact that a change in the optical power influences both stray field and coercivity profile, while a change in the external magnetic field only influences the total stray field.

The control unit 25 receives a comparison result of a comparing unit 22 which compares the result of an analyzing of the read-out data obtained from the decoder 28 with reference data stored in a non-volatile memory, e.g. look-up table 23. The analyzing is performed by an analyzing unit 21 which receives the read-out data from the decoder 28.

Fig. 2 shows signaling diagrams for an example of a disc with a range of space (downward magnetization (indicated by a corresponding arrow)) run lengths (I1, I2, I3, I4), separated by I1 marks (upward magnetization), as indicated in the upper line which shows a spatial arrangement of magnetized regions on a track of the disk 10. The expression "In" denotes a space run length with a duration corresponding to n channel bits (minimum space or mark regions), while the expression "In" denotes a mark run length with a duration corresponding to n channel bits. The resulting time dependency of the overlaps (second line from above) upon scanning with different copy window sizes w1, w2 and w3 are also indicated, as well as the MAMMOS signals or peaks (fourth line) generated with the external magnetic field (third line). For conventional, correct readout, the copy window should be smaller than half the channel bit length b (as applies for the copy window size w1 in Fig. 2). In this case, each mark channel will yield one MAMMOS peak and no peaks are generated for space channels. Thus, detection of *m* subsequent peaks indicates an I*m* mark run length, whereas *s* missing peaks indicate a I*s* space run length. This situation is indicated by the solid line in Fig. 2. For larger window sizes, e.g. w2, MAMMOS peaks will also be generated for space regions near a mark region because of the larger overlap (dashed line in Fig. 2). For example, an I1 mark will now yield three peaks instead of one. Obviously, I1 and I2 spaces can no longer be detected now. An I3 space will show one missing peak (instead of three). Even larger window sizes ($2.5b < w < 4.5b$), e.g. w3, cause a difference of four peaks in space and mark run length detection, while a I5 space is the smallest space run length that can be detected (by one missing peak).

Fig. 3 shows a table summarizing the effects of different copy window sizes on the number of peaks or missing peaks, which can be detected at predetermined run lengths. If the window size is smaller than half of the channel bit length b, the number of detected peaks and missing peaks of the read-out data corresponds to the run length of the recorded information. If the copy window size is in the range between b/2 and 2.5b, the number of detected peaks equals to the recorded mark run length plus two peaks and the number of missing peaks equals to the recorded space run length minus two peaks (provided that the run length is three or more). Moreover, if the copy window size is in the range between 2.5b and 4.5b, the number of detected peaks equals to the recorded mark run length plus four peaks and the number of missing peaks equals to the recorded space run length minus four peaks, and so on.

With the help of a table like this, which might differ for different read and write strategies, but can be derived very easily (similar to the construction of Fig. 2), a measurement of the copy window can be done at the comparing unit 22, based on which the field strength and/or the optical power is controlled using the above error signals 38, 39 generated by the control unit 25. Since the copy window increases with increasing laser power (as well as ambient temperature and external magnetic field), it is possible to do power and/or field control during read-out e.g. by detection of run length violations in the written data and/or by using a test area with pre-defined data patterns consisting of known mark and space run lengths. Especially the first option is attractive since much less or no disc capacity has to be reserved for power calibration, as the user data is used for this purpose. Moreover, when the window has been measured, (most of) the previous data stream of (missing) peaks can be translated into correct run length data, again using the table information of Fig. 3, which may be stored in the look-up table 23. In this way, the effects of environmental changes, e.g. changes in the ambient temperature, the external field strength (coil to disc distance), and even mild variations in the disc properties can be corrected on the fly.

The run length violations are determined by the analysing unit 21 e.g. based on a determination of the peak numbers in the read-out signal by a pulse counting function or based on a measurement of the space periods in the read-out signal by a timer function.

Assuming an (0,6) modulation, which means that the smallest marks and spaces are I1 and $\underline{I1}$, while the largest marks and space regions are I7 and $\underline{I7}$, respectively. Thus, if the smallest mark run length in a data sequence observed by the analyzing unit 21 is larger than 1 (e.g. 3 subsequent peaks), the comparing unit 22 determines a correction of 2 peaks (for all previous data) and thus a window size between b/2 and 2.5b. If the largest

observed space run length (I7) shows, e.g. only 3 missing peaks instead of 7, the comparison unit 22 determines a correction of 4 peaks and a window size between 2.5b and 4.5b. It is noted that with such a large window, only I5 and larger space run lengths can be detected and corrected, again demonstrating the need for rather tight laser power control. In both cases, the optical power and/or the field strength should be reduced by a corresponding amount, which is determined at the control unit 25 based on the comparison results. The run length characteristic of the modulation may be preset in the analyzing unit 21 or the look-up table 23 based on an information provided on the disk 10 or input by an input function of the disk player.

For even better control of the required laser power, a look-up table or a number of algorithm parameters may be pre-recorded on the disc 10 at a pre-scribed section. The look-up table may store a pre-determined window vs. laser power data characteristic of the disk 10, which may be read and used by the control unit 25 to generate the control signals. For larger linear velocities (e.g. CAV operation or different readout speeds), the laser power should be increased to reach the same temperature. Thus, the table could either include the disk radius as a variable or an interpolation scheme between e.g. inner and outer radius.

A simple solution for the initially described problem resulting from the discrete nature of the error signal(s) and the non-uniformity problem is to make the first and/or second error signal 38, 39 proportional to the relative occurrence of the detected number of additional or missing peaks.

Fig. 5 shows a diagram of the first and/or second error signals 38, 39 (vertical axis) vs. the readout parameters, e.g. radiation power and/or field strength, (horizontal axis) for an improved readout control with continuous nature of the error signal, according to the preferred embodiment of the present invention. In Fig. 5, respective arrows indicate a range of nominal readout parameters, where the first and/or second error signals 38, 39 are zero, and a range of controlled readout parameters. The controlled range comprises continuous regions where the error signal is varied continuously in dependence on the readout parameters. The shaded areas, where the error signal is varied continuously, represent transition regions due to disk non-uniformity.

Such a continuously varying error signal can be obtained e.g. by calculating, e.g. in the control unit 25, the running average of the violations detected by the comparing unit 22, or by a time-averaging or integrating operation. For example, a violation of +1 peak during 25% of the time (and nominal during the remaining 75%) would yield an error of +0.25, -1 peak for 50% of the time would yield an error of –0.50, etc. Such a solution,

however, would still need to integrate over large data sequences for a reliable and stable error signal. Any other functional relationship between the error signal value and the determined relative occurrence may be used and may be stored at the control unit 25 or in the look-up table 23 or any other look-up table or memory.

A further improvement or optional modification therefore is to combine the above improved control with small test areas, e.g. those mentioned above or additional ones, provided on the disk at e.g. regular intervals with a known data pattern, e.g., an I1I1 or an I3I3 carrier or an I1I3I3I1 pattern. From such a known pattern the number of additional peaks is directly obtained by counting the detected number of peaks and subtracting the expected number. Because a few run lengths are in this case already sufficient for reliable detection, many of these areas can be provided, while keeping the capacity overhead very small. This will lead to a faster, more accurate control and therefore a reduced number of readout errors. In a practical implementation, the error signals, i.e. first and/or second error signals 38, 39, obtained from these test areas, which my be provided e.g. in an address header portion, could be used exclusively in the control loop provided for controlling the readout parameter(s), e.g., radiation power and/or field strength of the external magnetic field.

Fig. 6 shows a schematic flow diagram of control procedure according to the preferred embodiment. In step S101, the test area (header portion) is detected, e.g., by the analyzing unit 21. Then, in step S102, peaks detected in the readout data are counted by the analyzing unit 21. In step S103, the control unit 25 calculates the first and/or second error signals 38, 39 based on an output information obtained from the comparing unit 22 and feeds these first and/or second error signals 38, 39 to the respective control loops. Thereafter, the control loop, i.e. the value of the first and/or second error signals 38, 39 is frozen or maintained until the next test area is detected after the procedure jumps back to the initial step S101. As an additional measure or improvement, the run length violation results determined by the comparing unit 22 from the user data between the test areas can be used to support or enhance the error or control signals.

It is noted that the present invention can be applied to any reading system for domain expansion magneto-optical disk storage systems. The functions of the analyzing unit 21, the comparing unit 22, the look-up table 23 and the control unit 25 may be provided in a single unit which may be a hardware unit or a processor unit controlled by a corresponding control program. The read-out data may be supplied directly from the optical pickup-unit 30 to the analyzing unit 21. The preferred embodiments may thus vary within the scope of the attached claims.

CLAIMS:

1. A method of controlling at least one readout parameter during a reading operation from a magneto-optical recording medium (10) comprising a storage layer and a read-out layer, wherein an expanded domain leading to a pulse in a reading signal is generated in said read-out layer by copying a mark region from said storage layer to said read-out layer upon heating by a radiation beam having a radiation power, said method comprising the steps of:

a) analyzing a pulse pattern in said reading signal;

b) comparing the result of said analyzing step with a run length characteristic of the data stored in said storage layer;

c) determining a relative occurrence of runlength violations obtained from said comparing step;

d) generating an error signal having a predetermined continuous functional relationship with said determined relative occurrence; and

e) controlling said at least one readout parameter based on said error signal.

2. A method according to claim 1, wherein said at least one readout parameter comprises at least one of said radiation power and a strength of an external magnetic field applied during said reading operation.

3. A method according to claim 1 or 2, wherein said predetermined functional relationship comprises a proportional relationship.

4. A method according to claim 3, wherein said proportional relationship is provided in a transition region between a non-controlled region and a controlled region.

5. A method according to claim 1 or 2, wherein said determination step comprises calculating a running average of detected runlength violations.

6. A method according to claim 1 or 2, wherein said determination step comprises a time-averaging or integration step.

7. A method according to claim 1, 2, 5 or 6, wherein said run length violations are determined by a pulse counting function or by a timer function.

8. A method according to claim 1 or 2, wherein said pulse pattern corresponds to the user data recorded on said recording medium (10).

9. A method according to claim 1 or 2, wherein said pulse pattern corresponds to a predetermined data pattern with pre-defined mark and space run length recorded at predetermined portions of said recording medium (10).

10. A method according to claim 9, wherein said generating step comprises generating said error signal during reading of said predetermined portions, and freezing said generated error signal during reading of other portions of said recording medium (10).

11. A method according to claim 10, wherein control based on said freezed error signal is enhanced based on runlength variations detected from user data recorded on said other portions of said recording medium (10).

12. A method according to claim 9, 10 or 11, wherein said predetermined portion is an address header portion.

13. A method according to claim 1 or 2, wherein said comparing step is performed based on a look-up table linking the value of said error signal to a corresponding value of said relative occurrence of runlength violations.

14. A reading apparatus for controlling at least one readout parameter during a reading operation from a magneto-optical recording medium (10) comprising a storage layer and a read-out layer, wherein an expanded domain leading to a pulse in a reading signal is generated in said read-out layer by copying a mark region from said storage layer to said read-out layer upon heating by radiation power, said apparatus comprising:

a) analyzing means (21) for analyzing a pulse pattern in said reading signal;

b) comparing means (22) for comparing the result of said analyzing by said analyzing means (21) with a run length characteristic of the data stored in said storage layer, determining a relative occurrence of runlength violations obtained from said comparing step, and generating an error signal having a predetermined continuous functional relationship with said determined relative occurrence; and

c) control means (25) for receiving said error signal and for controlling said at least one readout parameter based on said error signal.

15. A reading apparatus according to claim 14, wherein said at least one readout parameter comprises at least one of said radiation power and the strength of an external magnetic field applied during said reading operation.

16. A reading apparatus according to claim 14 or 15, further comprising storing means (23) for storing an information defining a relationship between a value of said error signal and a value of said relative occurrence.

17. An apparatus according to claim 14, 15 or 16, wherein said reading apparatus is a disk player for reading MAMMOS disks.

ABSTRACT:

The present invention relates to a method and apparatus for controlling at least one readout parameter during a reading operation from a magneto-optical recording medium comprising a storage layer and a read-out layer, wherein an expanded domain leading to a pulse in a reading signal is generated in said read-out layer by copying a mark region from said storage layer to said read-out layer upon heating by the radiation power and with the help of the external magnetic field. A pulse pattern in the reading signal is analyzed, and the analyzing result is compared with a run length characteristic of the data stored in said storage layer. Based on this comparison, a relative occurrence of runlength violations is obtained and an error signal is generated having a predetermined continuous functional relationship with said determined relative occurrence. The at least one readout parameter is controlled based on the generated error signal. Thereby, the error signal is made dependent on the relative occurrence of detected runlength violations, such that a smooth transition from the non-controlled state to the controlled state can be achieved so as to increase robustness of the control loop.

Fig. 5

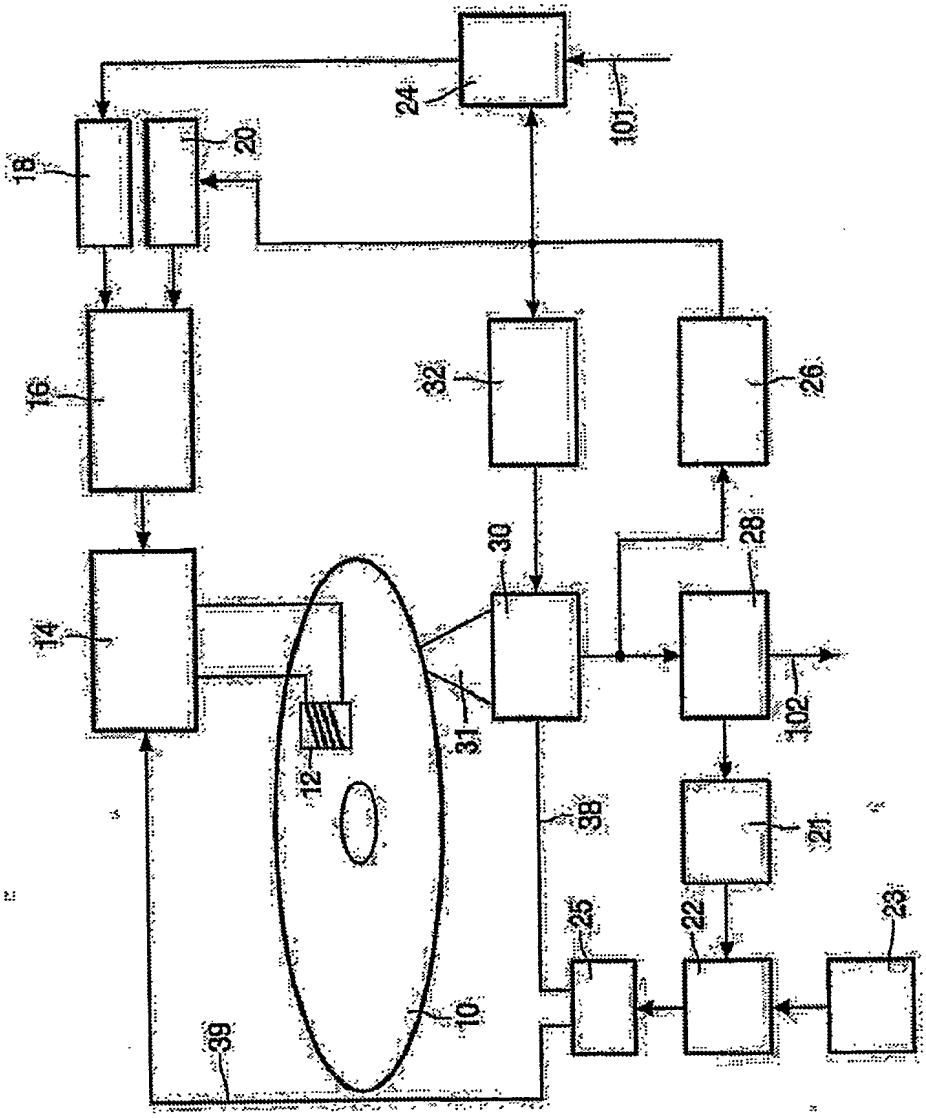

FIG.1

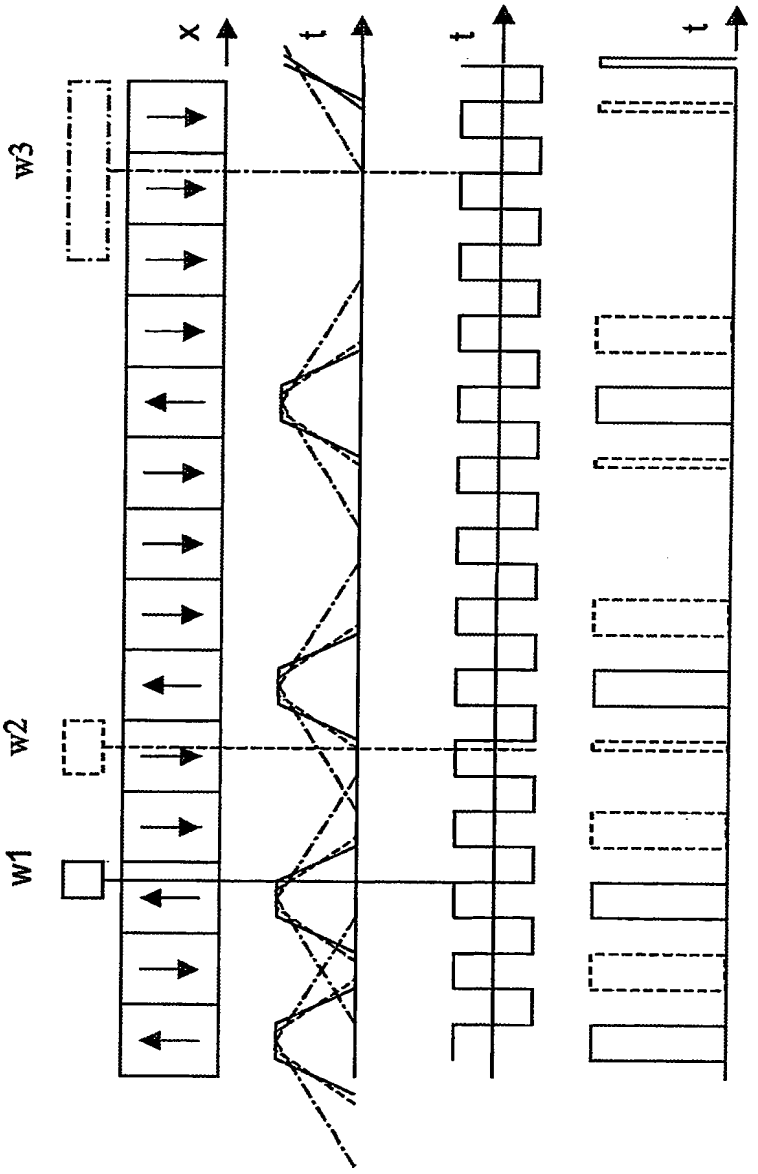

FIG.2

windowrange	markrunlength: peaks	spacerunlength:missing peaks
w<b/2	I(#)=# e.g.I5=5peaks	I(#)=# e.g.I5 =5missingpeaks
b/2<w<2.5 b	I(#)=#+2 e.g.I5=7peaks	I(#>2)=#-2 e.g.I5 =3missingpeaks
2.5b<w<4.5 b	I(#)=#+4 e.g.I5=9peaks	I(#>4)=#-4 e.g.I5 =1missingpeak
etc.	etc.	etc.

FIG.3

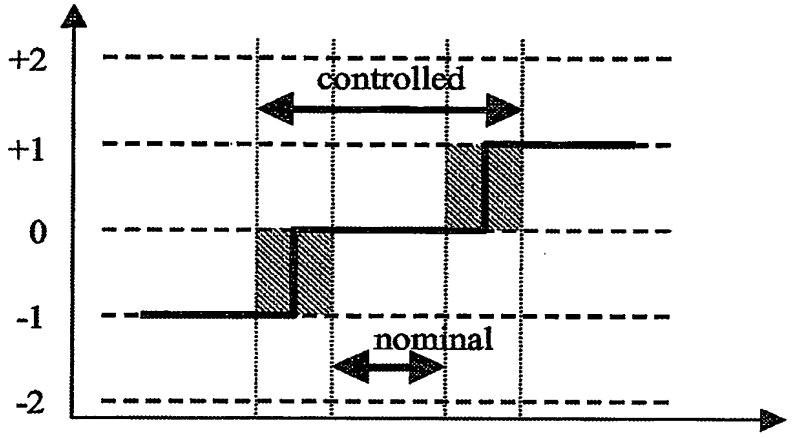

FIG.4

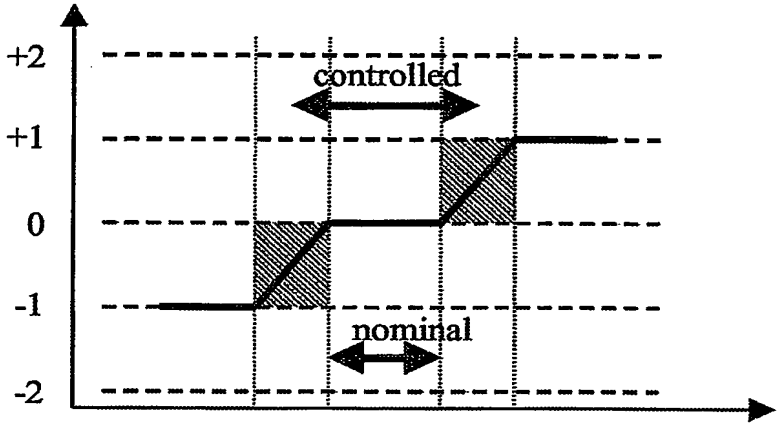

FIG.5

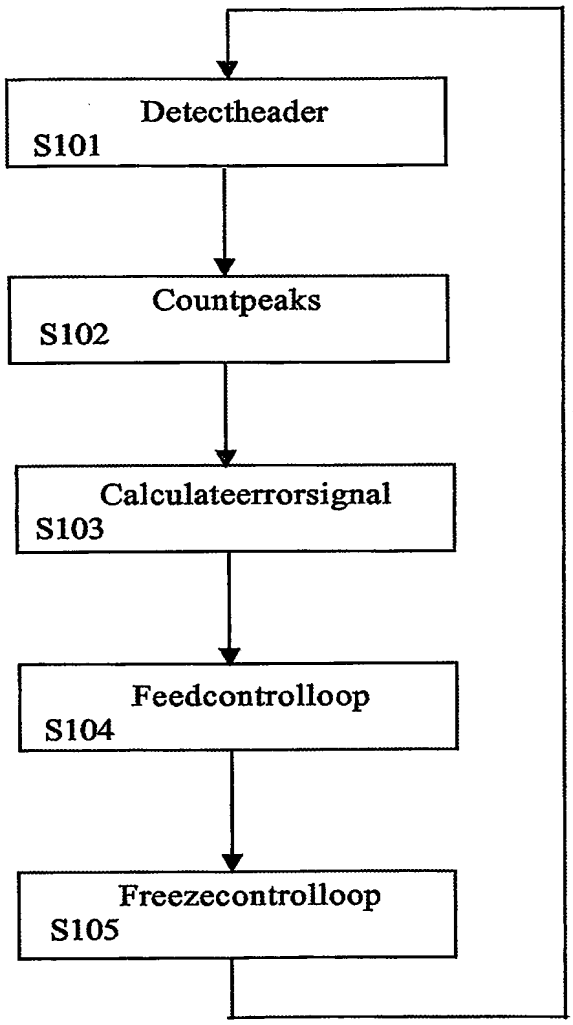
Detectheader
S101
Countpeaks
S102
Calculateerrorsignal
S103
Feedcontrolloop
S104
Freezecontrolloop
S105

FIG.6

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